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(54) Electromagnetic rotary stirring stator.

(57) Electromagnetic stirring means provides winding coils whose segments run longitudinally along the mould down one side and up the other with the phase relationship of different coils providing the rotary field. The coils are contained in a water-tight jacket (24A - D, 28A - D, 20. 22) to avoid contamination by the mould coolant water. Preferably the winding segments are hollow to carry a coolant medium.

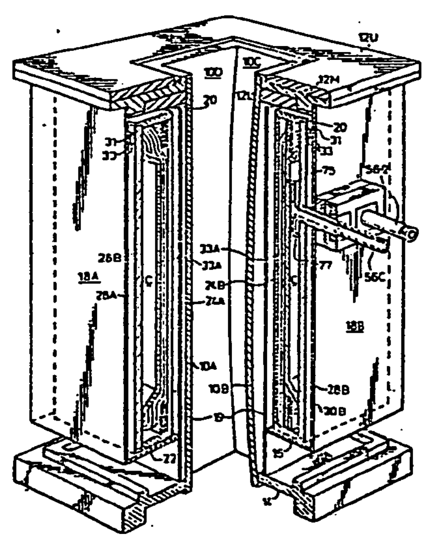

FIG.1.

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'ELECTROMAGNETIC ROTARY STIRRING STATOR'

This invention relates to means for providing electro-magnetic stirring for a continuous casting mould for steel.

This invention provides electromagnetic stirring apparatus for the provision of a magnetic field rotating about the path of steel passing through and solidifying in a continuous casting mould, the purpose of such field being to cause rotation of the steel which is still liquid in the mould.

U.S. Patent Application serial number 130,066, filed March 13 1980 and its Continuation-in-Part Application serial number 231,480 filed February 4, 1981 (now U.S. Patent number 4,454,909 dated June 19, 1984) related to magnetic stirring. The stirring apparatus provided a plurality of conducting segments running along the sides of the mould parallel to the steel flow direction therethrough. A magnetically permeable path extended about the mould and the segments and was substantially located outside the segments. The conducting segments were energized in pairs of groups of such segments, the groups forming a pair being disposed on approximately opposite sides of the mould. The groups from a pair, each bore the same angular disposition about the steel flow direction to respective groups of another pair. Each pair of the groups was energized in accord with a phase of alternating current and the electrical connection to the groups of a pair was such that current in one group was 180° out of phase with the current in the other group. The phase relationship between different pairs of groups was chosen so that the field produced by the pairs of groups taken collectively was transverse to the steel travel direction and rotated about the mould axis which is parallel to said direction to produce a corresponding rotation in the ste l.

The above arrangement was very advantageous. Since the magnetic path was outside the windings and no salient poles or teeth were used, the winding segments could be plac d side by side and

relatively close to the mould. The expense and complexity of the salient pole construction was avoided and the proximity of the windings to the mould together with their side-by-side arrangement along its side produced high field values. It was possible to get more ampere turns in the same space than with salient pole designs and the cost of the assembly was decreased since the design was simplified. Some disadvantages were encountered. Ordinary water, as is customary, was supplied within a mould jacket to cool the mould. Over a period of time such water contacted the insulation for the stirrer segments and eventually caused their deterioration and failure. Such deterioration was higher due to electrochemical action on the conducting segments and on the iron of the magnetically permeable path. In addition, where stranded wire was used in the windings, failure occurred due to fracture of such strands either because of vibration or the action of the cooling water. Moreover the fact that no independent cooling was supplied for the segmented windings placed a limitation on the current which could be carried in a segment requiring a relatively large number of segments in each group to achieve the ampere turns required.

This invention provides magnetic stirring equipment generally along the lines of the discussion above. In one aspect of the invention, the stirring segments, are contained in a distinct substantially water-tight enclosure preferably designed for location within existing jackets, so that the ordinary cooling water for the mould jacket cannot contact the windings or their insulation. In this was, failure of the windings due to the contact and / or electrochemical action by such ordinary cooling water is avoided. From another point of view the use of a separate water-tight container for the stirrer segment avoids the necessity of special control for the mould cooling water or the need for special insulation of the windings and of the permeable path to avoid contact by such water.

In another aspect of the invention, the winding segments, connected to be energized to produce electromagnetic stirring, are constructed of hollow metal to define a bore therethrough and a cooling medium from an external supply is caused to circulate through the bore in the segments. The conductors are thus internally cooled and do not therefore require cooling by the mould jacket water supply. Since the supply of the cooling medium to the winding segment bores is independent of the mould jacket coolant supply, it may be maintained pure and recirculated in a manner analagous to a refrigerator cycle. An aqueous ethylene glycol solution is preferably used as the cooling medium. However, other cooling or regrigerating gas or liquid may be used. Lower voltages and higher amperages can be used than with previous arrangements because of the use of hollow internally cooled conducting segments of relatively large cross-section. Thus, the required ampere-turns may be achieved with a relatively small number of conducting segments, which in the manner described hereinafter, may be assembled in groups for containment as an assembly in the water-tight enclosure, removing the possibility of copper strand failure which was present, because strands are not involved, and reducing the possibility of vibration failure, since groups are assembled as a unit and comprise a small number of relatively large conductors. The relatively large conductors allow the provision of relatively large central passages allowing easy flow of cooling water.

In drawings which illustrate a preferred embodiment of the invention:

Figure 1 is a cut-away perspective of a mould having a mould jacket and the electromagnetic stirring equipment contained therein,

Figure 2 shows the general arrangement of the winding segments,

Figure 3 is a transverse cross-section of winding segments,

Figure 4 is a schematic view showing the arrangement of the magnetically permeable path,

Figure 5 is a horizontal cross-section along the lines 5 - 5 of Figure 10,

Figure 6 is a schematic view showing the electrical connection of coils of winding segments to the A.C. supply,

Figure 7 is a schematic view showing the electrical winding sense of the segments to the mould. Figure 7 should be considered with both Figure 6 and Figure 2,

Figure 8 shows generally and schematically the coolant medium arrangement for the stator coil,

Figure 9 is a view of side B of the stator enclosure with the outer wall of such enclosure removed,

Figure 10 is a view of side A of the stator enclosure with the outer wall of such enclosure removed,

Figure 11 is a cut-away perspective of the stirrer jacket to show examples of connections to a coil 34, and

Figure 12 shows a vertical partial section to show the connection between the upper mould wall and the upper stator wall.

In the drawings, particularly Figure 1, a rectangular continuous casting mould includes opposed vertical mould walls 10A, 10C, on the short sides and opposed mould walls 10B and 10D on the long sides, to define a rectilinear cross-section as indicated in Figure 5. Customarily two of the opposing walls here 10B and 10D (see Figure 1) will be slightly curved in the same sense to initiate a change of direction of the steel slab being formed. Extending outwardly from the mould are upper and lower horizontal plates 12 and 14. Upper wall 12 comprises sub-walls 12U, 12M, 12L. Upper wall 12 with an intermediate lower wall 16 and lower wall 14 define the upper and lower limits for a mould jacket for receiving coolant water for cooling the muold. The inner boundary of the mould jacket is defined by the mould walls 10A,10B,10C and 10D while

the outer wall of the mould jacket is formed by outer walls 18A, 18B, 18C and 18D on the four sides of the mould. The magnetic stirrer jacket defined by upper wall 12 and lower walls 14 and 16, mould walls 10 and outer jacket walls 18, forms a chamber of the depth shown and forming a rectangular annulus about the mould in horizontal cross-section. Baffle wall 19 surrounding the mould wall but spaced therefrom and spaced from wall 12 is indicative of baffles generally used to provide the desired course for the coolant water over and about the mould wall. In general the supply of cooling water to the mould jacket, its circulation therein to cool the mould, and its egress from the jacket are not shown and will be constructed in accord with techniques antedating this disclosure and well known to those skilled in the art and hence not shown here. The mould as described and connecting the stirrer to be described is oscillated vertically during the casting process by means not shown but which are well known to those skilled in the art.

The magnetic stirring stator in accord with the invention is contained within an enclosure which takes the form of a rectangular annulus designed to be received within the mould jacket. The stator enclosure has upper and lower walls 20 and 22, defining the rectangular annulus shape and inner and outer walls on each of the four sides of the mould and forming with the upper and lower walls a water-tight enclosure for the windings. Upper and lower walls 20 and 22 are made of steel of high magnetic permeability. Inner walls 24A, 24B, 24C and 24D on the four sides of the mould are formed of stainless steel of low magnetic permeability and such walls are joined to each other and to the upper and lower walls in a fluid tight manner. The four outer walls of stator enclosure are composed of outer layers 28A - D of relatively non-magnetic stainless steel and linings 30A - D of magnetically permeable steel. The four side walls 24, 28, 30 (A-D) are joined at inner and outer corners and to the upper and lower walls 20 and 22 to complet the water tight stator enclosure which is therefore protected from the cooling

waterin the mould jacket which surrounds the stator enclosure. It will be noted that the four outer wall liners 30 form a magnetically permeable path extending around the outside of the stator bousing and surrounding the electric windings to be described. Such magnetic path is augmented by upper and lower walls 20 and 22 which are also of magnetically permeable material. Such magnetic path is also significantly augmented by plates 32A - D of magnetically permeable material. The components of the magnetically permeable path are indicated in schematic Figure 4. Plates 32A - D are respectively attached to the linings 30A - D of the corresponding of the outer wall at its upper and lower extremities and slope inward from each extremity to provide a vertical intermediate extent 33A adjacent the corresponding vertical extent of the stator winding to be described. Magnetically permeable plates 32B - D bear the same relationship to the outer walls to which they are attached and to the vertical extents of the windings on the corresponding sidesof the mould. It will be noted that the vertical extents of plates 32A - D join at the corners to form a magnetically permeable path about and adjacent the longitudinal segments of the windings.

The preferred method of supporting the stirrer jacket within the mould jacket is by welding steel projections 31 running transversely on each, the outside of walls of plate 28B of the stirrer jacket. Corresponding projections 33 are welded on the inside of wall 18A of the mould jacket. During installation of the stirrer, with the upper wall of the mold jacket removed, the stirrer is lowered into place until it rests supported by projections 31 or projections 33. The location of the suspended stirrer jacket is selected to allow the circulation of mould cooling water below, above and on all sides of the stirrer jacket.

A sub wall 21L forms part of the normal mould assembly and extends between mould wall 10 and mould jacket wall 18. This arrangement and that to be described are shown in relation to side 'B' of the

apparatus in Figure 12. At four spaced locations boss 17 is part of the upper wall 20 and each boss 17 and wall 20 below are provided with threaded bore to receive bolt 15 whose head is countersunk in sub wall 12 as shown in Figure 12. The boss 17 bolted with wall 20 to sub-wall 12L prevents upward movement of the electromagnetic stirring stator during vibration of the mould. Ridge 33 supporting ridge 31 on the stator prevents downward movement of the stator relative to the mould during such vibration. When wall 12 is removed for installing or removing the stator the threaded bores in boss 17 and wall 20 may be used by threading bolts therein which are attached to apparatus for lifting or lowering the stator.

The winding segments are composed of copper extrusions 38 of square outline covered with insulation 40. The windings are preferably formed into coils the shapes of which are best indicated in Figure 2. These shapes may be considered to be coils made up of turns of conducting segments with each turn having the shape (if flat) of a wide square "O" with curved corners having upper and lower transverse extents T joined by right and left hand longitudinal extents LR and LL. In fact the rectangular "O" is not flat but bent to correspond to the corners of the inner wall of the stator jacket so that the transverse segments TA which extend across one inner wall (say) 24A and are bent about the corner where it meets the adjacent inner walls 24B or 24D so that the longitudinal segments LA are disposed along the adjacent inner walls 24B and 24D. The longitudinal segments in a coil 34 (to which stirring action is due) cover an area from adjacent the corner of two walls 24 to approximately the middle of the wall on which the longitudinal extents of that coil are located. Opposed coils 34A and 34C with transverse segments TA and TC along inner walls 24A and 24C on the short sides, therefore together provide a 'group' (in the sense used in the application and claims) of longitudinal segments LRA and LLC together covering the most, and the central transverse portion of, wall 24B with the left hand longitudinal segments LLC of coil C and the right hand

longitudinal segments LRA of coil A providing such extents ('right' and 'left' are used in the sense of an observer looking inwardly toward the mould axis). Conversely the right hand longitudinal segments LRC of coil C and the left hand longitudinal extents LLA of coil A form the group of longitudinal segments on side 24D. The opposed coils 34B and 34D are similarly constructed with the difference that the transverse extents TB and TD of coils 34B abd 34D are located outside of the curved portions of the segments of coils A and C. Hence the longitudinal segments of coils B and D are displaced inward to proximity to the mould wall from the tranverse segments by the shaping of the inwardly sloping extents S. With the coils shaped and arranged as described it is noted that each coil 34A, 34B, 34C and 34D preferably contains an inner layer of turns of a square spiral arrangement connected in series with an outer layer of turns in a square spiral arrangement. Each coil is connected in series with the opposite coil i.e. coil 34A with coil 34C and coil 34B with coil 34D. See particularly Figures 6 and 7 for the specific winding arrangement. The connections to a two phase supply are as best shown in Figure 6 and 7 with phase 1 connected through outer coil 34A, inner coil 34A, inner coil 34C, outer coil 34C and to common ground, and phase 2 (90° out of phase with phase 1) connected through inner coil 34D, outer coil 34D, outer coil 34B, inner coil 34B to common ground. Within the phase 1 series circuit the layers and coils are connected so that at a given time all currents in the segments on side B (from the longitudinal segments of coils 34A and 34C) are in one direction (here up the mould) and all currents on side D from the other longitudinal extents of coils 34A and 34C are in the opposite direction (here down the mould). The connections for coils 34B and 34D are arranged so that these coils' longitudinal extents carry instantaneously current in the up direction on the A side of the mould and in the down direction on the C side of the mould. Each series circuit will of course vary cyclically in accord with the AC supply. Since phase 1 and phase 2 are energized to be 90° out of phase with each other, it will be obvious that, with the connections and the energization shown, the

combined effect of the coils will be to provide a magnetic field across the mould generally transverse to the mould axis and rotating thereabout with the frequency of the AC supply.

It is convenient to refer to a 'group' of winding segments being all those segments with longitudinal extents corresponding to a single phase and in the preferred embodiment forming all of the segments on one side of the mould. The constituency of such groups is as follows:

Group	On side of Mould	Is made up of longitudinal segments
A	A	LRD and LLB
B	B	LRA and LLC
C	C	LRB and LLD
D	D	LRC and LLA

With the coils thus arranged the plates 32 connect at their extremities to the magnetically permeable liner 30 and at their corners to each other but are as close as possible to the longitudinal extents of the windings to bring the magnetically permeable path as close as possible to the longitudinal winding segments.

The stirring apparatus is preferably arranged so that the upper end of the vertical segments corresponds approximately to the expected level of the meniscus for the poured steel.

The coolant fluid is supplied to the inner bores 42 defined in the hollow conducting segments. We prefer to do this by causing the fluid to flow along the electrical paths indicated in Figure 6 from the common ground to the phase 1 and phase 2 terminals in parallel. A schematic of the liquid circuit is shown in Figure 8. Although the components will vary widely with the coolant fluid or refrigerant used, the principle will remain the same. Figure 8 pr - supposes that the coolant is a 30% aqueous solution of ethylene

glycol. A pump 50 supplies the solution to a chiller 52 and the chilled solution is supplied to the phase 1 and phase 2 coils in parallel. The coolant liquid emerging from the coil bores is filtered, purified, de-ionised and, if necessary, the solution strength adjusted at the apparatus represented by block 34. The treated liquid is returned to the pump for cooling and re-circulation to the coils. The coolant circuit may be made in any one of a number of ways well known to those skilled in the art. Another coolant fluid including a gaseous state refrigerant such as freon can be used with suitable changes in the circuit exterior to the coils which changes would be obvious to those skilled in the art. It is important, from the point of view of the invention, to note that the coolant circuit for the coils is completely independant of the coolant water supply for the mould jacket, which mould jacket coolant water is customarily dirty and conductant to an un-desireable degree.

The phase 1, phase 2 and common ground terminals of the coils are located on side B, connections 56 - 1, 56 - 2 and 56 - C from the coil terminals are designed to extend through walls 30B, 28B and 18B to carry hollow electrical conductors with central coolant bores to the outside of the mould jacket for connection thereto of electrical and coolant fluid supplies. The connections of the coolant liquid supply and return to conductors inside and outside the mould jacket utilize the fact that a liquid contacting the inside only of hollow conductors should not affect the electrical voltage or current characteristics.

Although we do not regard the invention as limited to any particular frequency for the phase A and phase B, A.C. inputs we note that, at this time, it is preferred to use between 3° and 5 Hz.

It it is not deemed necessary to describe in detail each connection to and between the coils 34A, 34B, 34C, and 34D. Each such connection will be by a hollow conductor carrying electric current

and connected for electrical flow in accord with the schematics of Figures 6 or 7 and carrying coolant and connected for coolant flow on the same courses as shown in Figure 7. The connections from terminals 56 to the coils 34 and between the coils 34 will be located in the space C (Figure 1) between the magnetically permeable plate 32 and magnetically permeable plate 30 on the same side of the mould. As examples only of the connections to and between windings 34, Figure 11 shows connection 75 from terminal 56C to the inner layer of coil 34B (see also Figure 8). Figure 11 also shows a fragment connection 77 from the terminal 56C which is directed to the right in Figure 11 to the outer layer of coil 34C (see also Figure 8). Figure 11 also shows a fragment of connection 79 from the inner layer of coil 34A to the inner layer of coil 34C. The other connection to and between the coils will be of similar arrangement with the connections outside of plates 32 and connected with the coils proper through apertures 81 (see Figure 11 in the plates).

Although the components described specifically are for a rectangular mould, it will be obvious that the invention applies to moulds of square, circular form or any other shape. Whatever shape the four coils 34 may be shaped for application to give four longitudinal segment groups each one carrying current 90° out of phase (in the same sense) with the adjacent group and with each set of longitudinal segments in a group made up of right and left hand segments of two opposing coils.

It will also be noted that the aspect of a water-tight enclosure for the stator windings with an independent cooling system for the windings applies with different winding arrangements than those specified, different cooling procedures (so long as these are independent of the mould jacket cooling) and whether the conducting segments are hollow and / or internally cooled or not. Further aspects of the invention particularly the water-tight stator enclosure and the internally cooled coils, unrelated to the specific physical shape of the bent rectangular '0' shaped coils,

are not limited to a two phase AC supply but are applicable to three or more phases.

Although the stator enclosure is formed of steel in the preferred embodiment, the enclosure may be made of fibreglass resin or otherwise so long as a magnetically permeable path is provided about the winding.

CLAIMS

1. Electromagnetic rotary stirring means for use in combination with a continuous casting mould defining a mould axis parallel to the general flow direction and having a mould jacket surrounding said mould, said mould jacket being designed to receive and circulate water for cooling said mould, characterised in that the electromagnetic rotary stirring means comprises an electromagnetic stirring stator designed to be located within said mould jacket (10A-D, 18A-D, 12, 14) and surrounding said mould, said electromagnetic stator containing windings (38) designed when energised by multiple phase current, to create in said mould a magnetic field rotating about the mould axis, means for providing an enclosure (24A-D, 28A-D, 20,22) for said windings (38) designed to exclude said mould cooling water therefrom, and means for cooling said windings in said enclosure.

2. Electromagnetic rotary stirring means as claimed in Claim 1 including means forming part of said stator defining a magnetically-permeable path surrounding said windings and said magnetically-permeable path being contained within said enclosure.

3. Electromagnetic rotary stirring means as claimed in Claim 1 wherein said enclosure-providing means comprises an inner wall (24A-D) designed to be located adjacent and spaced from said mould; an outer wall (28A-D) designed to be located and spaced from the outer wall (18A-D) of said mould jacket, and upper and lower walls (20,22) respectively, joined to said inner and outer walls and designed to be respectively contained within said mould jacket, said inner, outer upper and lower walls defining a substantially water-tight enclosure for said windings.

4. Electromagnetic rotary stirring means as claimed in Claim 3 including means within said enclosure defining a magnetically-permeable path surrounding said windings, and said magnetically-permeable path including magnetically-permeable material lining said outer stator wall.

5. Electromagnetic rotary stirring means as claimed in any one of Claims 1 - 4 including means in said enclosure for cooling said windings.

6. Electromagnetic rotary stirring means as claimed in Claim 5 wherein said winding cooling means comprises constructing the individual segments (38) of said windings of hollow cross-section to provide a path for coolant fluid along said windings, and means, operative when said windings are contained in said stator jacket allowing connection of said segments to an exterior source of coolant fluid.

7. Electromagnetic rotary stirring means in combination with a continuous casting mould for steel, defining a steel movement direction therein, and having a water jacket for surrounding said mould supplied with a cooling medium for cooling the interior of said jacket, characterised in that the electromagnetic rotary stirring means comprises, an electromagnetic stirring stator for said mould, designed to be contained within said mould jacket and to surround said mould, comprising groups of winding segments, each group comprising a plurality of winding segments located inside said mould jacket (10A-D, 18A-D, 12,14) and extending in a longitudinal direction relative to said mould over a predetermined extent and each group being paired with a similar group of winding segments located on approximately the opposite side of said mould; means for electrically connecting the segments of one group with the segments of its similar group so that electrical energization may be applied to the winding segments to cause

current to flow in one direction in the group on one side of said mould and in the other direction in the paired group on the other side of said mould, where at least two such pairs of groups are provided with the groups in such pairs angularly disposed from one another in the same sense on opposite sides of said mould; means providing a magnetically-permeable path extending about said mould outwardly of said segments; means for defining a substantially water-tight enclosure (24A-D, 28A-D, 20, 22) for said stator and means for utilising a cooling medium to cool the stator segments and connections thereto, located inside said enclosure.

8. Electromagnetic rotary stirring means as claimed in Claim 7 wherein said means utilising a cooling medium comprises constructing said segments of hollow construction, means, exterior to said mould jacket connected to supply a cooling medium to flow along the inside of said segments.

9. Electromagnetic rotary stirring means in combination with a continuous casting mould for steel, defining a steel movement direction therein, a mould jacket for surrounding said mould, supplied with a cooling medium for cooling the interior of said jacket, characterised in that the electromagnetic rotary stirring means comprises an electromagnetic stirring stator designed to be contained within said mould jacket (10A-D, 18A-D, 12, 14) and to surround said mould having groups of winding segments, each group comprising a plurality of adjacent winding segments for location extending in a longitudinal direction over a predetermined extent relative to said mould, each group being paired with a similar group of winding segments located approximately on the opposite side of said mould, means for electrically connecting the segments of one group with the segments of its paired group so that electrical energisation may be applied to the winding segments to cause current to flow in one direction in the group on one side of said mould and in the opposite direction in the other

side of said mould, where at least two such pairs of groups are provided with each of the groups being angularly disposed from groups of other pairs in the same sense on opposite sides of said mould, said segments being of hollow construction, defining bores therein whereby means, exterior to said mould jacket (10A-D, 18A-D, 12,14) may be connected to supply cooling medium to flow along the bores of said segments.

10. Electromagnetic rotary stirring means as claimed in Claim 9 wherein said electromagnetic stirring stator includes means providing a magnetically-permeable path extending about said mould outwardly of said segments.

11. Electromagnetic rotary stirring means as claimed in Claim 9 or 10 including means for providing a substantially water-tight enclosure for said stator, said enclosure being designed for containment within said mould jacket.

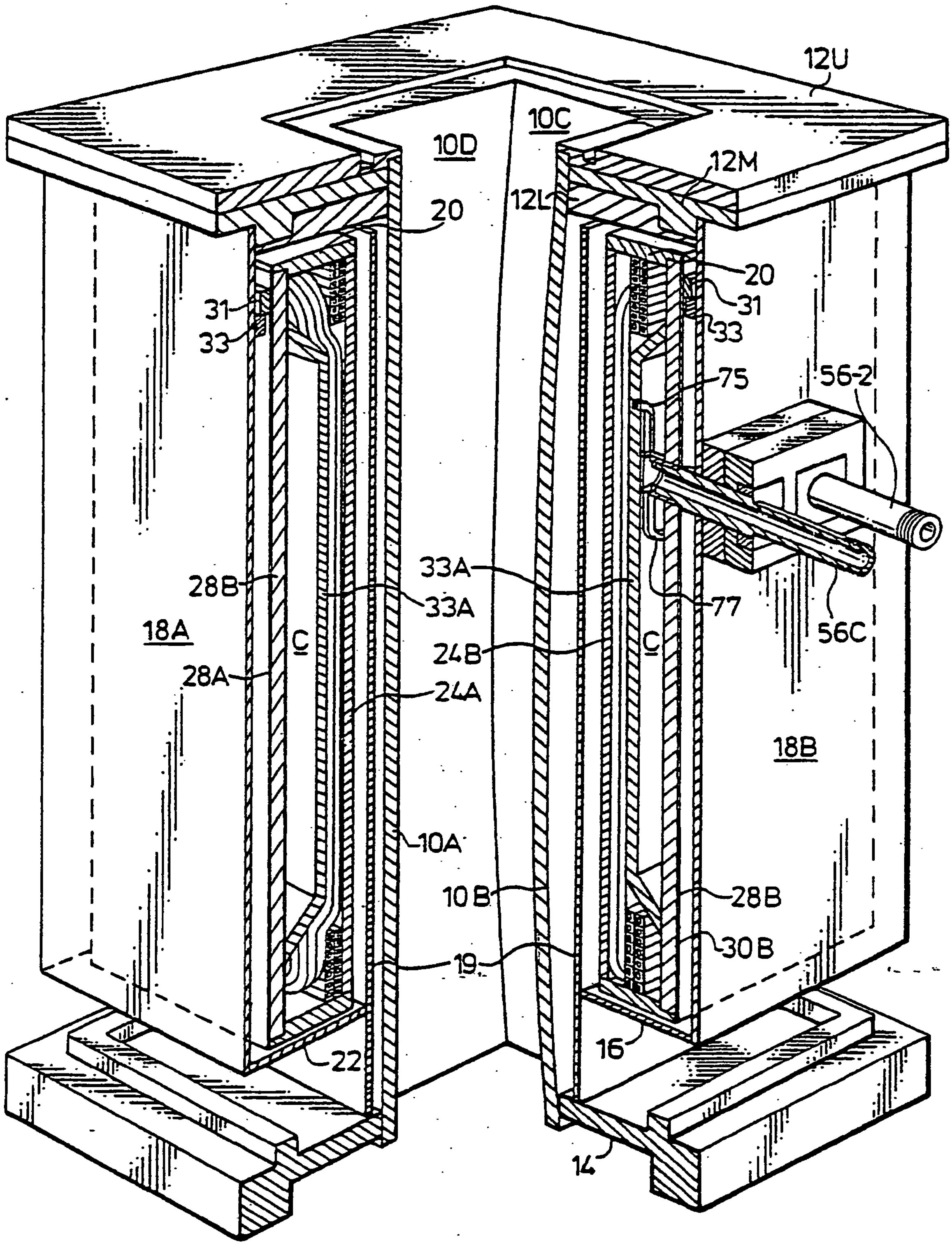
12. A stator for electromagnetic stirring in a continuous casting mould, characterised in that the stator comprises four conducting coils, each coil comprising a plurality of turns and each turn comprising first and second segments arranged to run transverse to the mould axis joined at each end by first and second segments arranged to run longitudinally of the mould axis, said coils being shaped to be 'C' shaped in plan view and to be applied to receive the mould within the mouth of the 'C' and said four coils each being angularly disposed at approximately 90° from each other about the mould axis, whereby four groups of approximately longitudinal segments are provided, each group being engularly disposed at approximately 90° to each other about the mould axis, each group being composed of the first longitudinal segments of one coil and the second longitudinal segments of the coil opposite, and connections allowing energising of said coils so that the current flows in one direction in one group and in the opposite direction in the

opposite group and so that the current in one opposed pair of groups is approximately 90° out of phase with the current in the other opposed pair of groups.

13. A stator for electromagentic stirring in a continuous casting mould as claimed in Claim 12, wherein said segments are hollow, defining bores there-through and means are provided for connection of a source of coolant fluid to the bores of said segments.

14. A stator for electromagentic stirring in a continuous casting mould, as claimed in Claim 13, wherein said segments are of a rectilinear cross-section.

15. A stator for electromagnetic stirring as claimed in any one of Claims 12 - 14, wherein said four coils are contained in a substantially water-tight stator jacket shaped and dimensioned to be received about the mould and within the mould jacket.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12M
12L
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31
33
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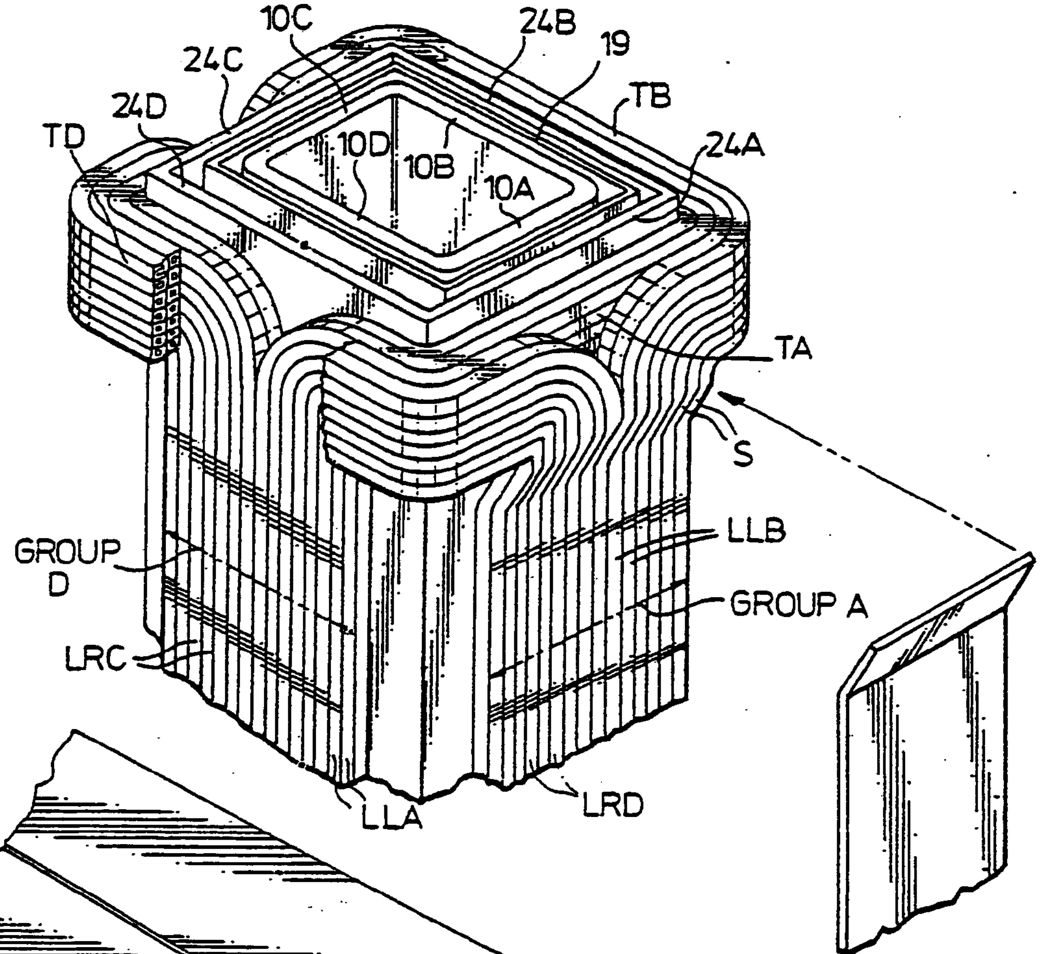
77
18A
C
C
56C
28A
24B
24A
18B
10A
10B
28B
30B
19
22
16
14

FIG.1.

FIG. 2.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24D
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GROUP D
GROUP A
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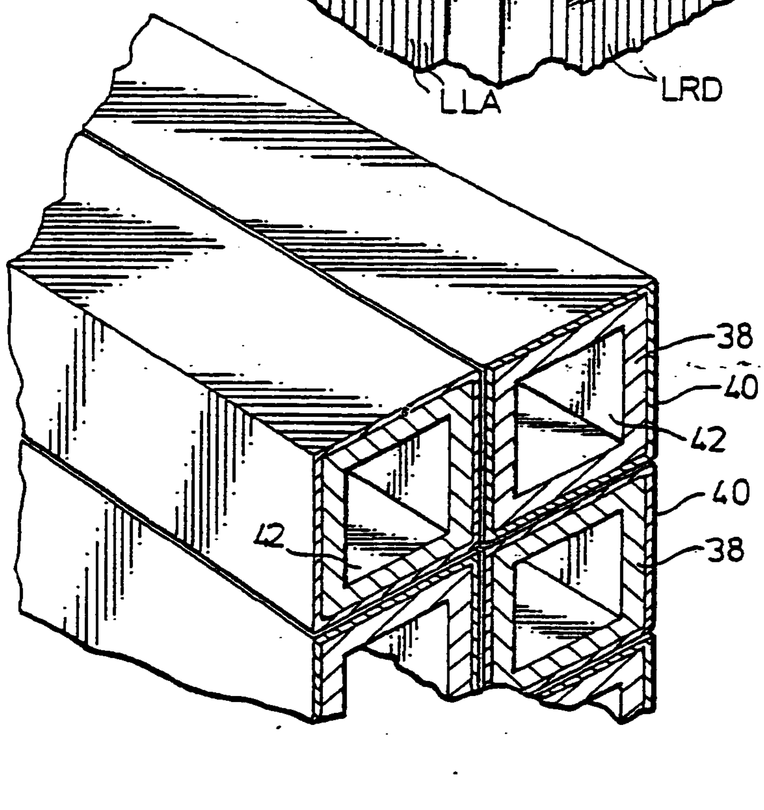
LLA
LRD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38

FIG. 3.

FIG.4.

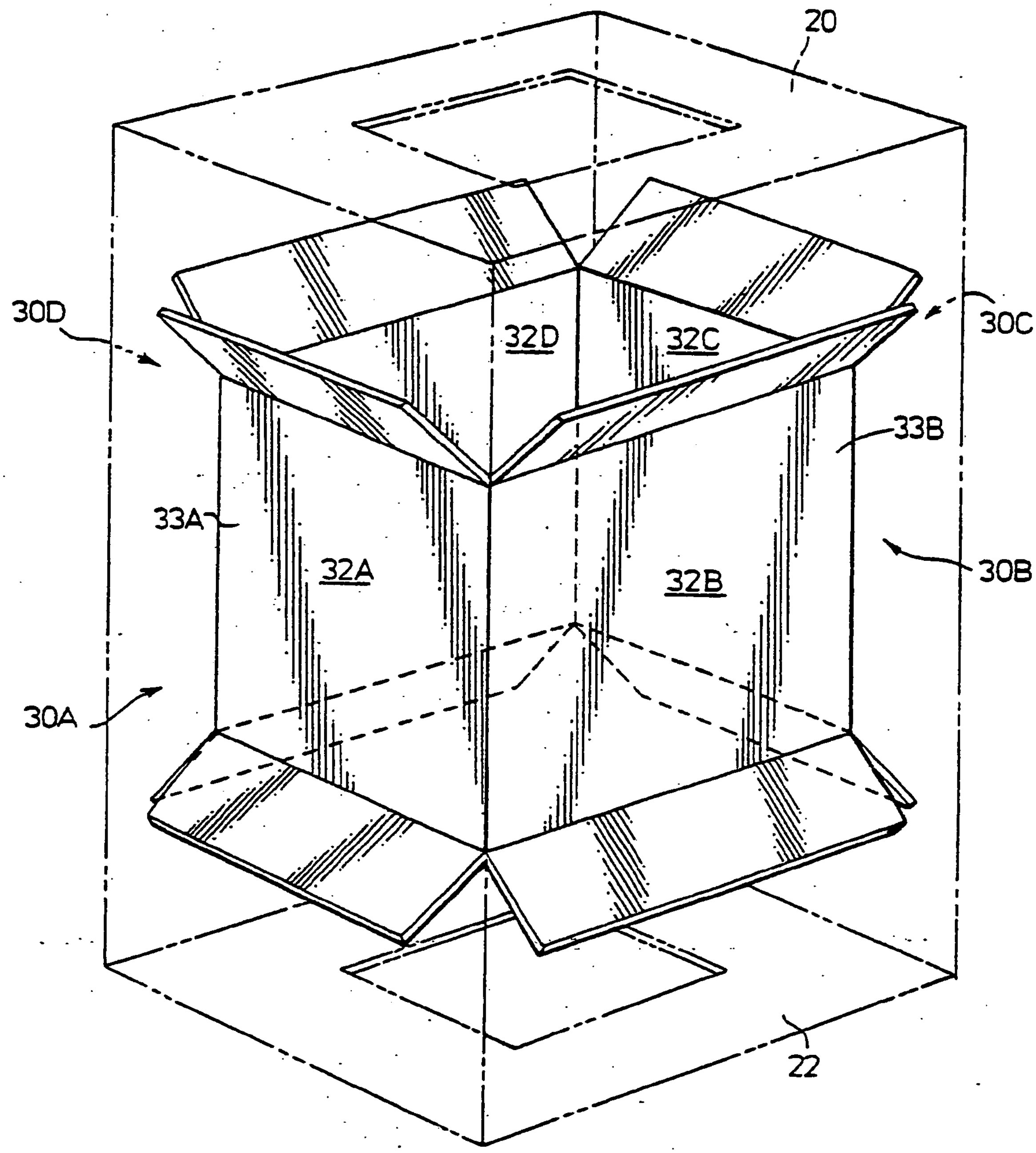


FIG. 5.

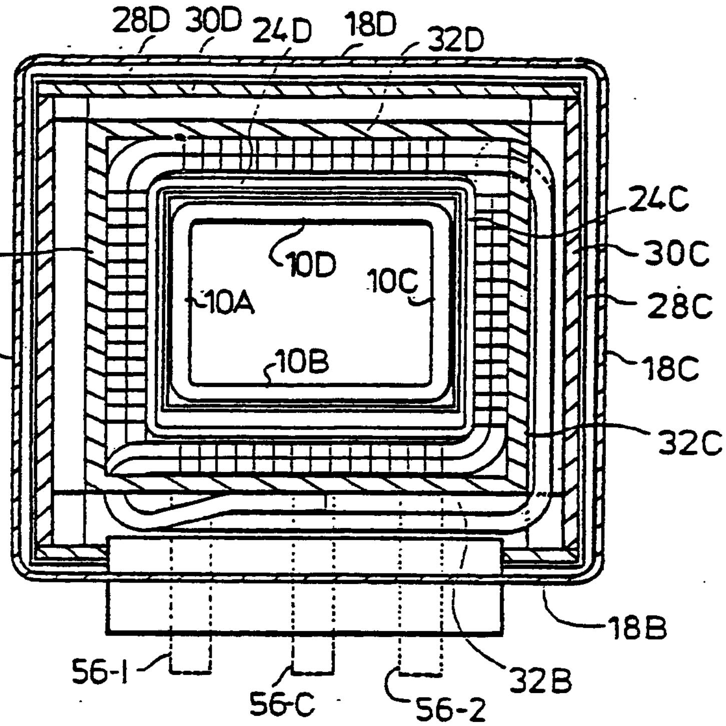


FIG. 6.

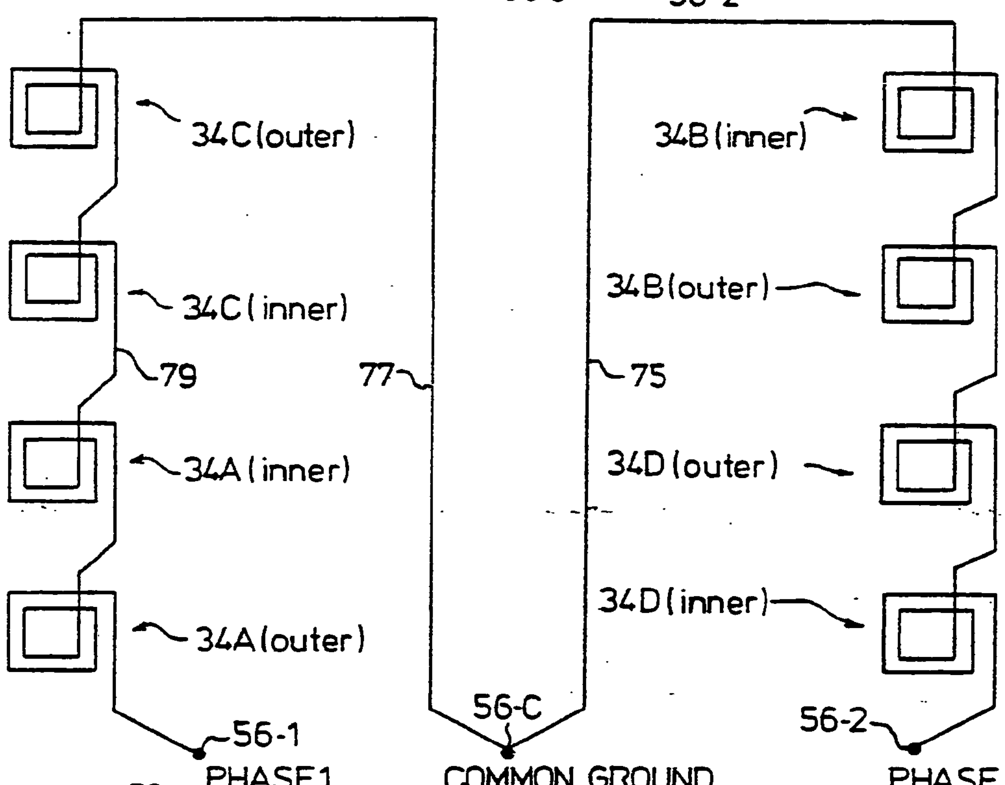
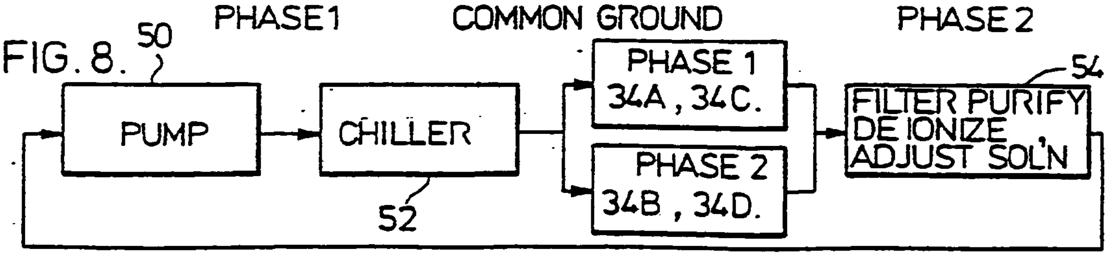


FIG. 8.



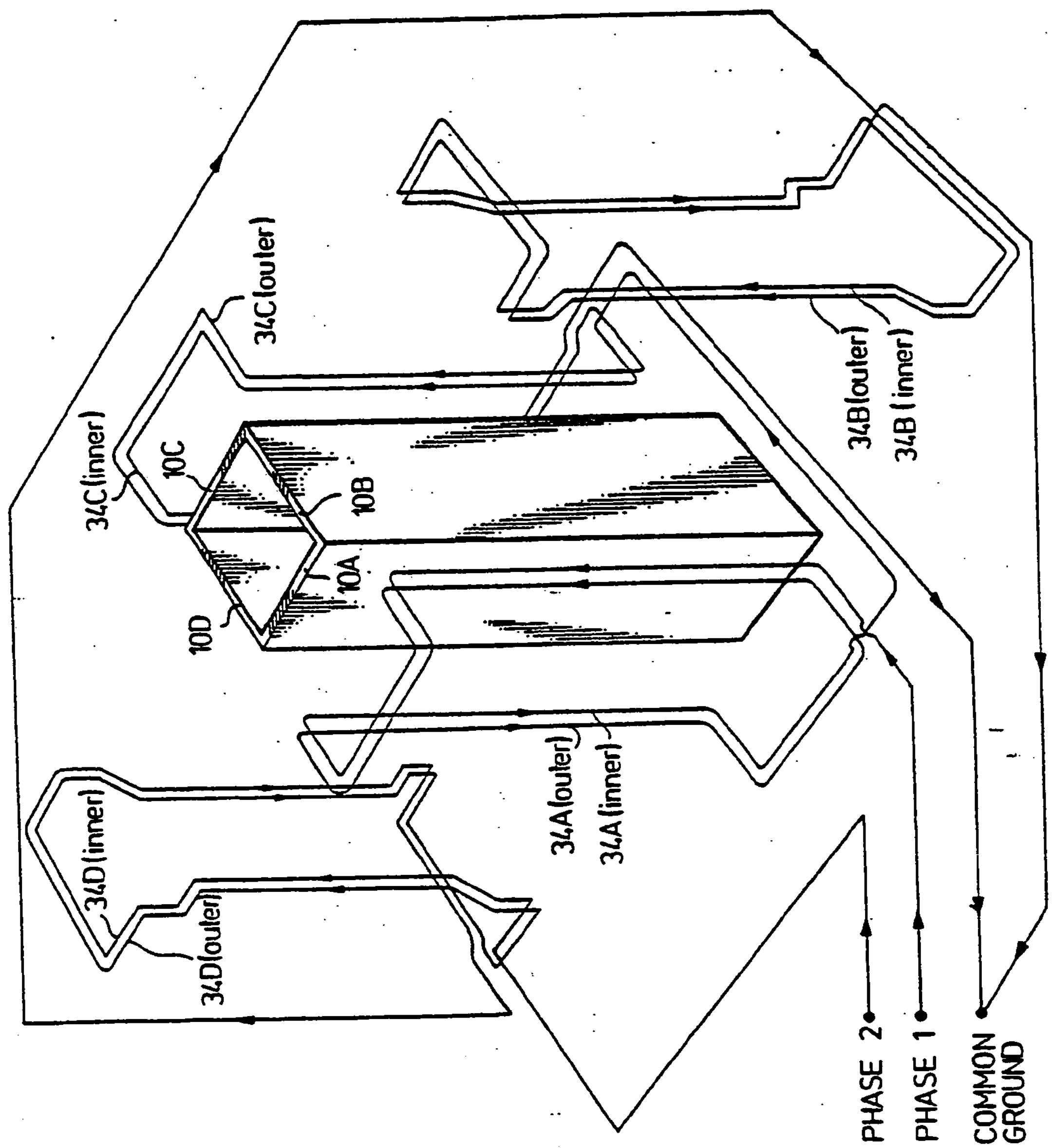
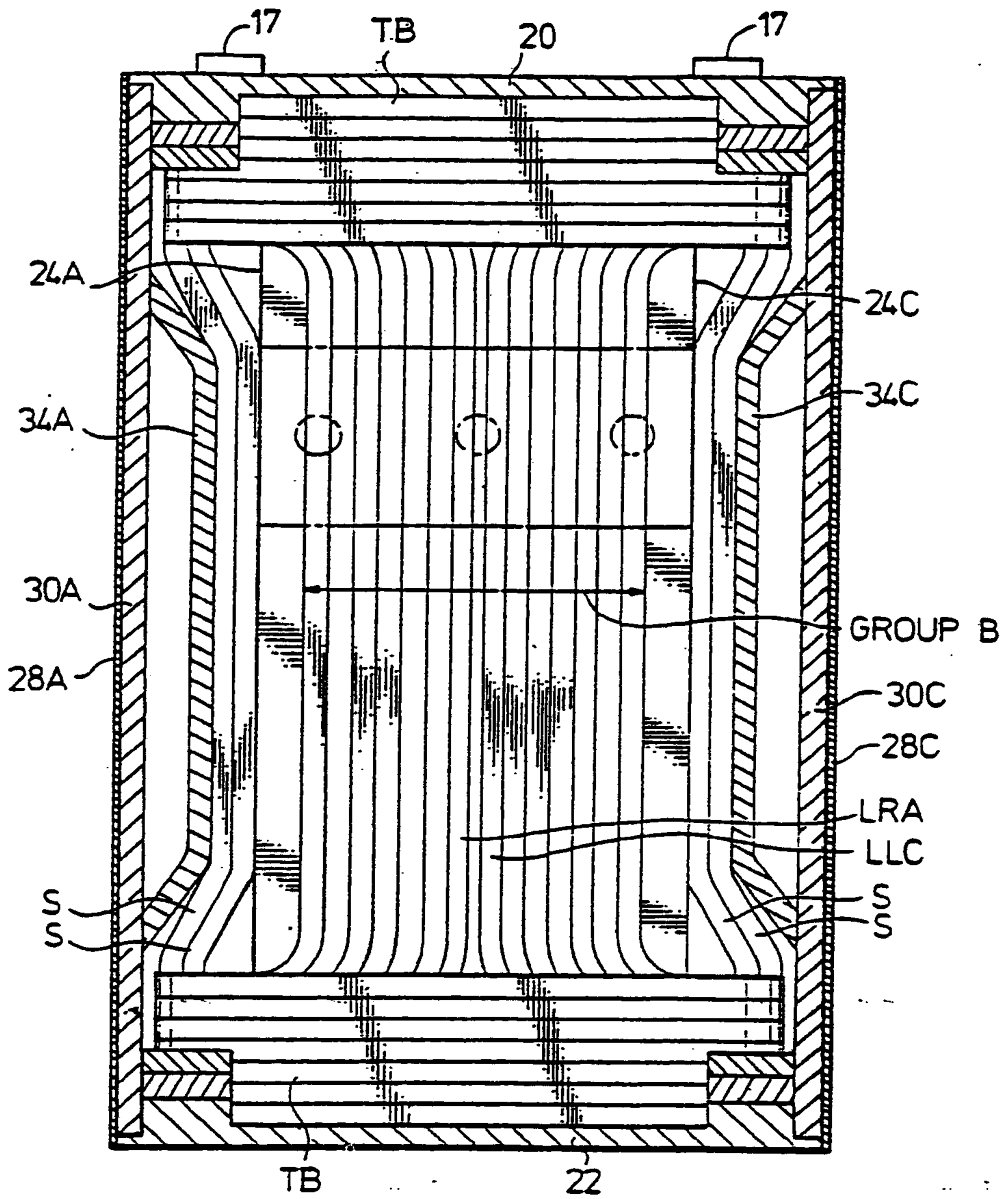

34C(outer)
34C(inner)
10C
10B
10A
10D
34B(outer)
34B(inner)
34A(outer)
34A(inner)
34D(inner)
34D(outer)
PHASE 2
PHASE 1
COMMON GROUND

FIG. 7.

FIG. 9.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TB
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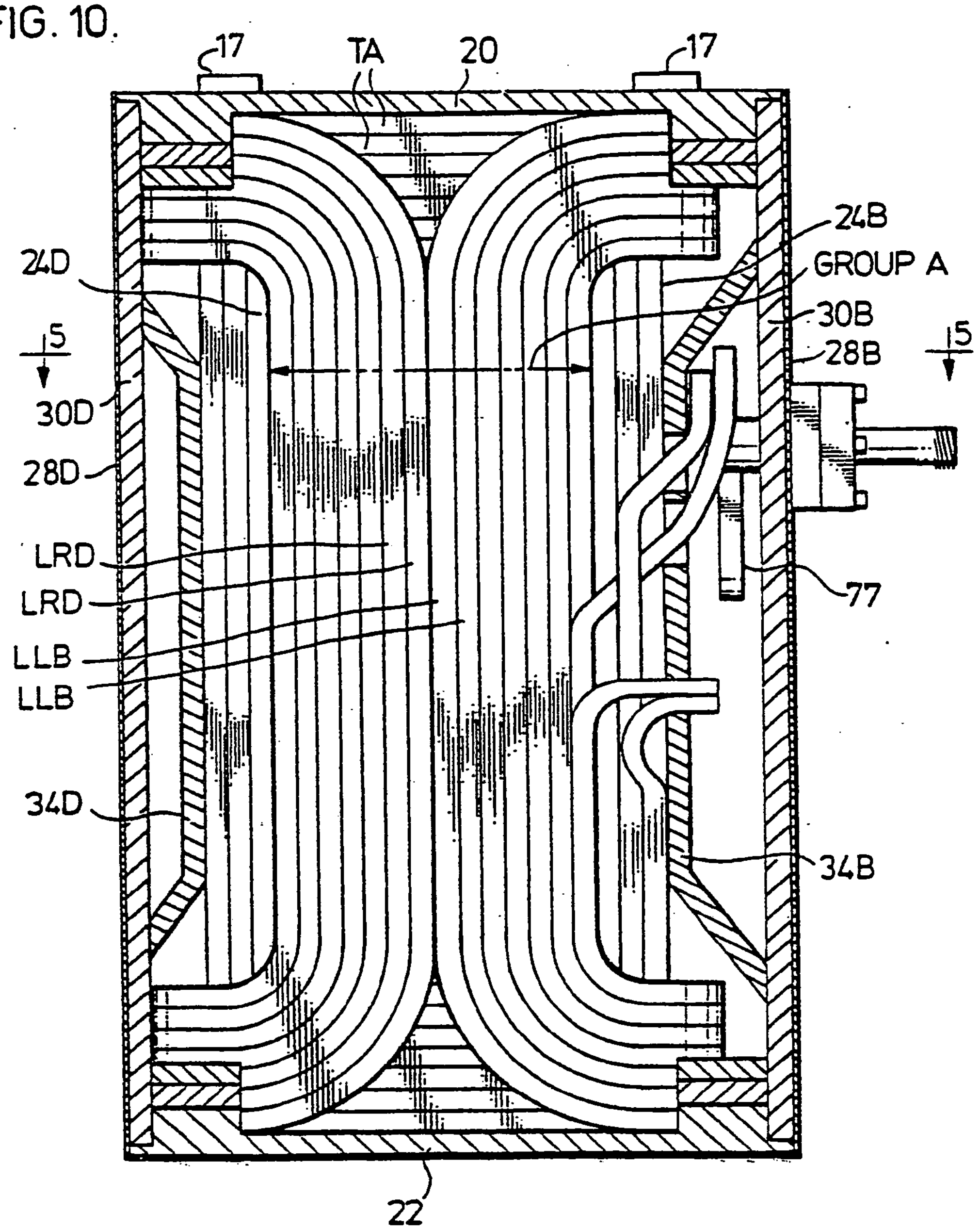
17
24A
24C
34A
34C
30A
GROUP B
28A
30C
28C
LRA
LLC
S
S
S
S
TB
22

FIG. 10.



17
TA
20
17
24B
GROUP A
24D
30B
28B
5
15
30D
28D
LRD
LRD
77
LLB
LLB
34D
34B
22

FIG. 11.

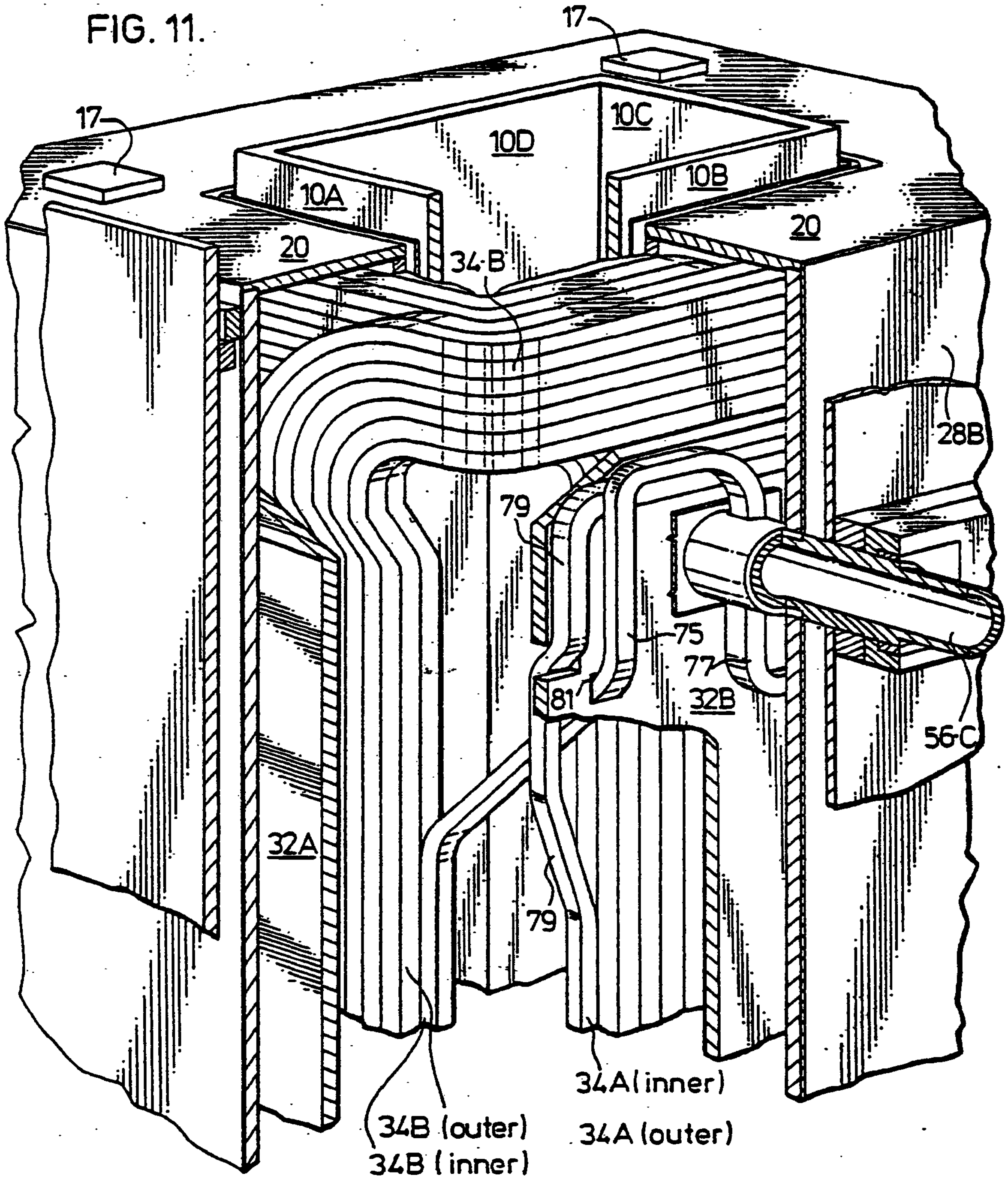
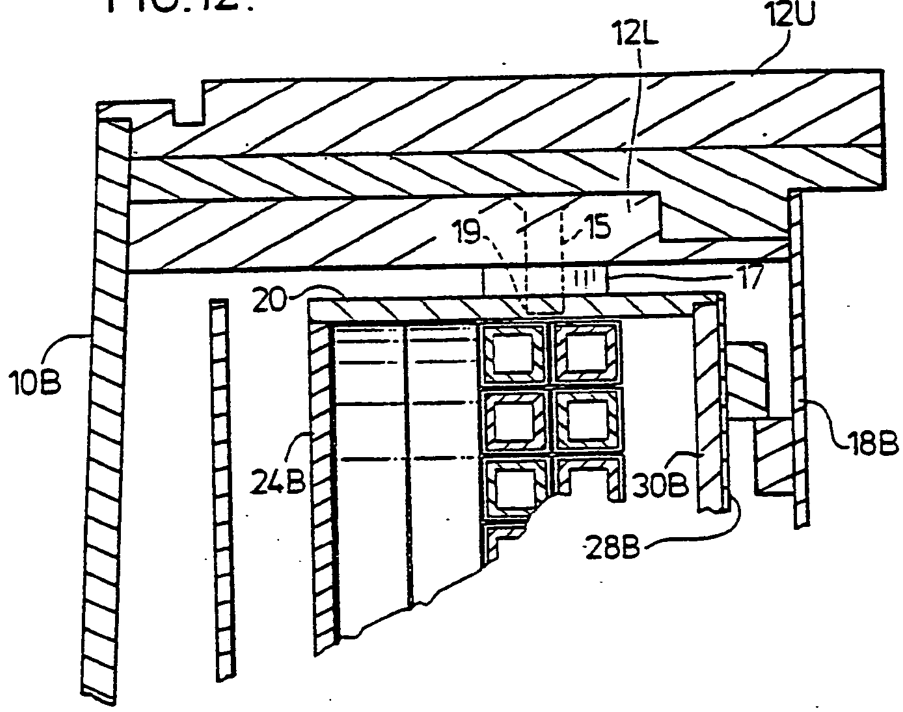

17
17
10D
10C
10A
10B
20
20
34B
28B
79
75
77
81
32B
56C
32A
79
34A (inner)
34B (outer)
34A (outer)
34B (inner)

FIG.12.



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(54) Electromagnetic rotary stirring stator.

(57) Electromagnetic stirring means provides winding coils whose segments run longitudinally along the mould down ne side and up the other with the phase relationship of different coils providing the rotary field. The coils are contained in a water-tight jacket (24A - D, 28A - D, 20. 22) to avoid contamination by the mould coolant water. Preferably the winding segments are hollow to carry a coolant medium.

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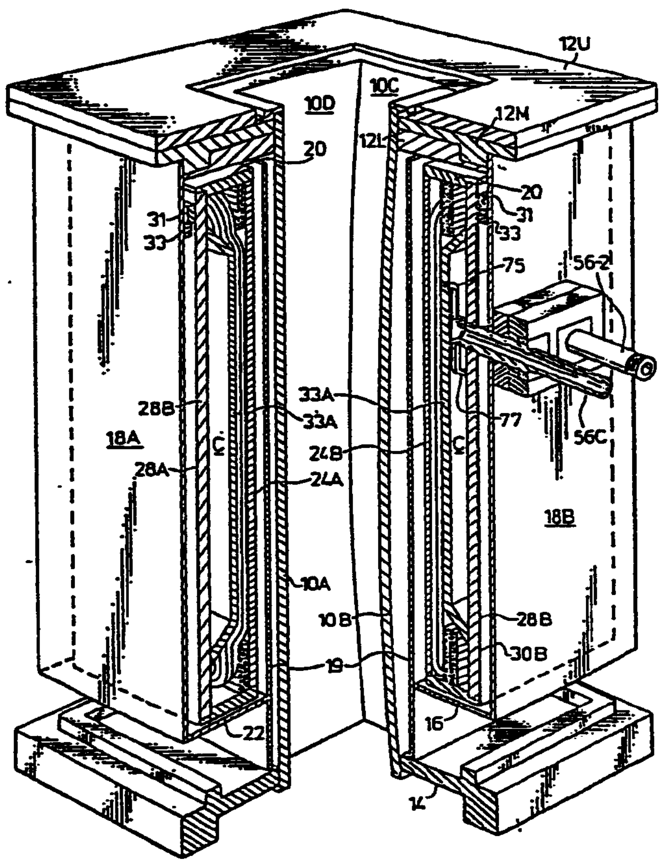
12U
10D
10C
12M
121
20
20
31
33
31
33
75
56-2
33A
33A
28B
77
24B
C
C
56C
18A
28A
24A
18B
10A
10B
28B
30B
19
16
22
14

FIG.1.

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EUROPEAN SEARCH REPORT

0165793
Application number

EP 85 30 4307

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
D,A	US-A-4 454 909 (J.A. MULCAHY) * claims 1, 8 *	1,7,12	B 22 D 11/10 B 22 D 11/12 B 22 D 27/02
A	DE-A-2 528 931 (USINOR) * claims 5-8; figure 1, reference number 4 *	1,8,12	
A	DE-A-2 362 720 (COMPAGNIE ELECTRO-MECANIQUE) * claim 1 *	1	
A	US-A-2 963 758 (G. PESTEL et al.) * claims 3, 4; figure 10 *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B 22 D 11/00
B 22 D 27/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	02-06-1986	GOLDSCHMIDT G

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